

REMARKS

Claims 1-24 are currently pending in the present patent application. In an Office Action mailed 28 November 2005, the Examiner allowed claims 10-14 and objected to claims 5-8 but indicated these claims were allowable if properly rewritten in independent form. Claims 5-8 have been so rewritten and are now allowable.

Claims 1 and 9 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,198,008 to Thomas ("Thomas") and claims 2-4 were rejected under 35 U.S.C. §103(a) as being unpatentable over Thomas and further in view of U.S. Patent Application Publication No. 2004/0017962 A1 to Lee *et al.* ("Lee"), U.S. Patent No. 5,673,284 to Congdon *et al.* ("Congdon"), and what would have been obvious to one of ordinary skill in the art, respectively. The Examiner also rejected claims 15-24 under the first paragraph of 35 U.S.C. § 112 as failing to comply with the written description requirement but were indicated as otherwise allowable if this rejection is overcome.

Amended claim 1 recites, in part, a method of optically interconnecting layers in an optical integrated circuit including a substrate that includes removing portions of a first cladding layer to form an angled sidewall in a first cladding layer. The angled sidewall has an angle that is less than 90 degrees, and the method further includes forming an optical interconnect layer on the angled sidewall.

Thomas neither discloses nor suggests such a structure. In fact, Thomas is closer to the structure discussed in the background section of the present application in which the optical interconnects have 90 degree sidewalls. The sidewalls of optical interconnects 22 and 30 in Thomas have 90 degree sidewalls as indicated by the Examiner. Claim 1 as amended covers the angled sidewalls of the present invention and expressly indicates such angled sidewalls are not 90 degree sidewalls. Although claim 1 has been amended to expressly indicate the sidewalls do not have a 90 degree angle, it should be noted that under MPEP § 2111 during examination the pending claims must be "given their broadest reasonable interpretation consistent with the specification." The background of

the present application expressly discusses a conventional structure having 90 degree angles and Figure 2F, for example, along with the detailed description of the described embodiments make it clear that embodiments of the invention do not include 90 degree sidewalls. Thus, interpreting the term "angled" as being 90 degrees does not appear to be consistent with the specification.

For all these reasons, the combination of elements recited in amended claim 1 is allowable. Dependent claims 2-4 and 9 are allowable for at least the same reasons as claim 1 and due to the additional limitations added by each of these claims.

Claim 15 recites, in part, an optical integrated circuit formed on a substrate having a second optical transmission layer with an angle relative to a lower optical transmission layer that is defined by the angle of the angled sidewall. The angle has a value between approximately five degrees and a maximum angle having a value defined by indices of refraction of the second optical transmission layer and the first cladding layer. Through total internal reflection, light having the same mode as light propagating through the lower optical transmission layer propagates through the second optical transmission layer.

One embodiment of the present invention is illustrated in Figures 2E and 2F, which show an optical transmission layer 204a coupled to a second optical transmission layer 220 having a vertical optical interconnect 222 formed on an angled sidewall 218 coupled to an upper optical transmission layer 224. As explained with reference to this embodiment, light having a given mode and a wavelength λ propagates through the layers 204a and 220 and then through the vertical optical interconnect 222 and into the layer 224. See paragraph 21. The light is confined in the vertical optical interconnect 222 through total internal reflection. *Id.* The angled sidewall 218 θ has an angle such that light propagating through the layers 204a, 220 is incident upon a boundary between the optical interconnect 222 and the cladding layer 208 at an angle that is equal to or less than a critical angle defined between the boundary and the incident light. As discussed in paragraph 22, in one embodiment the layers **204a**, **220** are silicon oxynitride SiON and the cladding layer **208** is silicon dioxide SiO₂. In this

embodiment, the angle θ of the optical interconnect 222 must be less than 50 degrees. See paragraph 22.

From the description of the embodiment shown in Figures 2A-2F, the angle θ may be between some minimum value and some maximum value less than 90 degrees. The silicon oxynitride SiON and silicon dioxide SiO₂ embodiment, for example, expressly indicates the angle θ must be less than 50 degrees in this example. The range for the angle θ must have some minimum angle since otherwise, if the angle could be zero degrees, then the resulting structure would be just a conventional straight optical transmission layer. The minimum value of five degrees recited in claim 15 was inserted to distinguish the recited structure from the Tien patent (3,948,583) as explained in the prior amendment filed on June 14, 2005. Recall, as explained in that prior amendment Tien disclosed only a very small angle which, in the example given is defined by a 60:1 slope which translates into an angle of less than 1 degree.

The recitation of a minimum angle of 5 degrees is fully supported by the original written description. Another minimum value having a value greater than 5 degrees could have alternatively been selected and would also be fully supported by the original disclosure. The value approximately 5 degrees was chosen to distinguish over the very small values covered by Tien, with equivalents of this recited lower limit being as small as is permissible in view of Tien.

From the original detailed description of the described embodiments of the present invention, such as the embodiment of Figure 2F, one skilled in the art will understand that the angle of the sidewall 218 and thus the optical interconnect 222 is such that light of a given mode propagates through layers 204a, 220 and through the interconnect through total internal reflection. Thus, while not expressly discussed in the detailed description there is no suggestion that the mode of propagating light would be different in different portions of the structure, as was the case in the Giallorenzi patent (3,992,079) cited in the prior office action. In reading the detailed disclosure of the present patent application, one skilled in the art would understand that light of the same mode propagates in all

portions of the structure. This language was added to claim 15 merely to expressly distinguish this claim from the Giallorenzi patent and is fully supported by the written description of the present application.

For these reasons, claim 15 satisfies paragraph 1 of Section 112 and is therefore allowable. Independent claims 18 and 22 are allowable for reasons similar to those discussed above with reference to claim 15. All claims depending from claims 15, 18, and 22 are allowable for at least the same reasons the independent claim from which each depends and due to the additional limitations added by each of these dependent claims.

The present patent application is in condition for allowance. Favorable consideration and a Notice of Allowance are respectfully requested. Should the Examiner have any further questions about the application, Applicant respectfully requests the Examiner to contact the undersigned attorney at (425) 455-5575 to resolve the matter.

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Respectfully submitted,

GRAYBEAL JACKSON HALEY LLP

Paul F. Rusyn
Registration No.: 42,118
155 108th Ave. NE, Suite 350
Bellevue, WA 98004-5973
Telephone: (425) 455-5575
Facsimile: (425) 455-1046

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